(12) UK Patent Application (19) GB (11) 2 094 647 A

(21) Application No 8206214
(22) Date of filing 3 Mar 1982
(30) Priority data
(31) 8108059
(32) 14 Mar 1981
(33) United Kingdom (GB)
(43) Application published 22 Sep 1982
(51) INT CL³ A63B 21/00
(52) Domestic classification A6M 8J1A2 8J1AY 8J1Y 8JY
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(58) Field of search A6M
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(54) Physical exercise device

(57) A flexible inextensible line (40) (e.g. a cord) is attached at one end to a rotatable cylindrical drum (30), the other end of the cord being provided with a handle (41), and an electric motor (10) and a suitable gear train (20) are provided to impart a variable torque to the drum. The torque must be overcome by the efforts of a user pulling on the cord (40). Means (60) are provided to measure, and to display a signal corresponding to, the efforts of the user so that the progress of an athlete can be assessed and monitored. A variety of body exercises can be carried out by exchanging the handle (41) for, e.g. a waist- or head-harness or a set of rowing-bars.

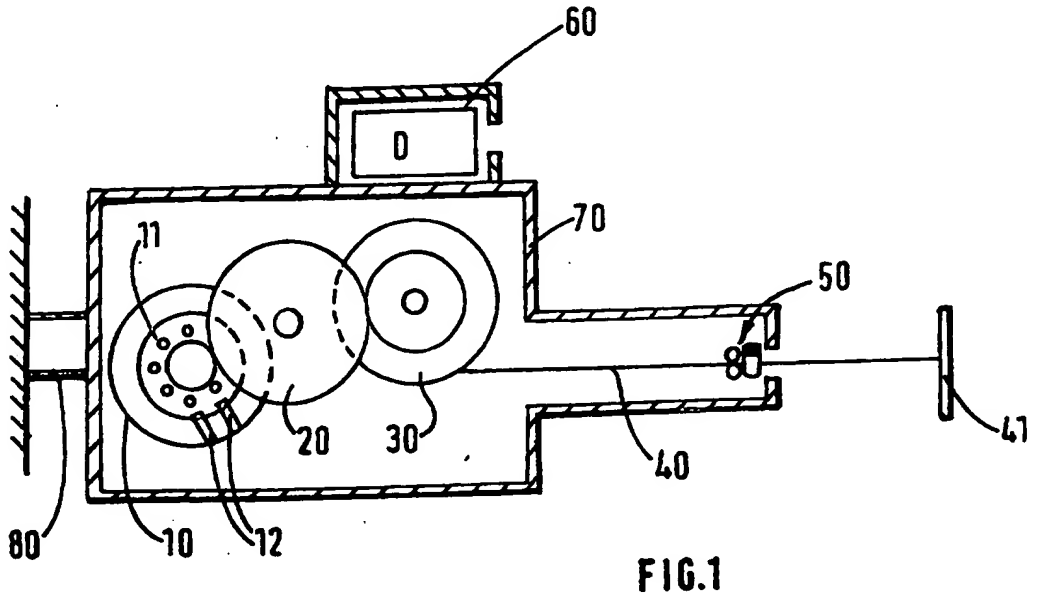

FIG.1

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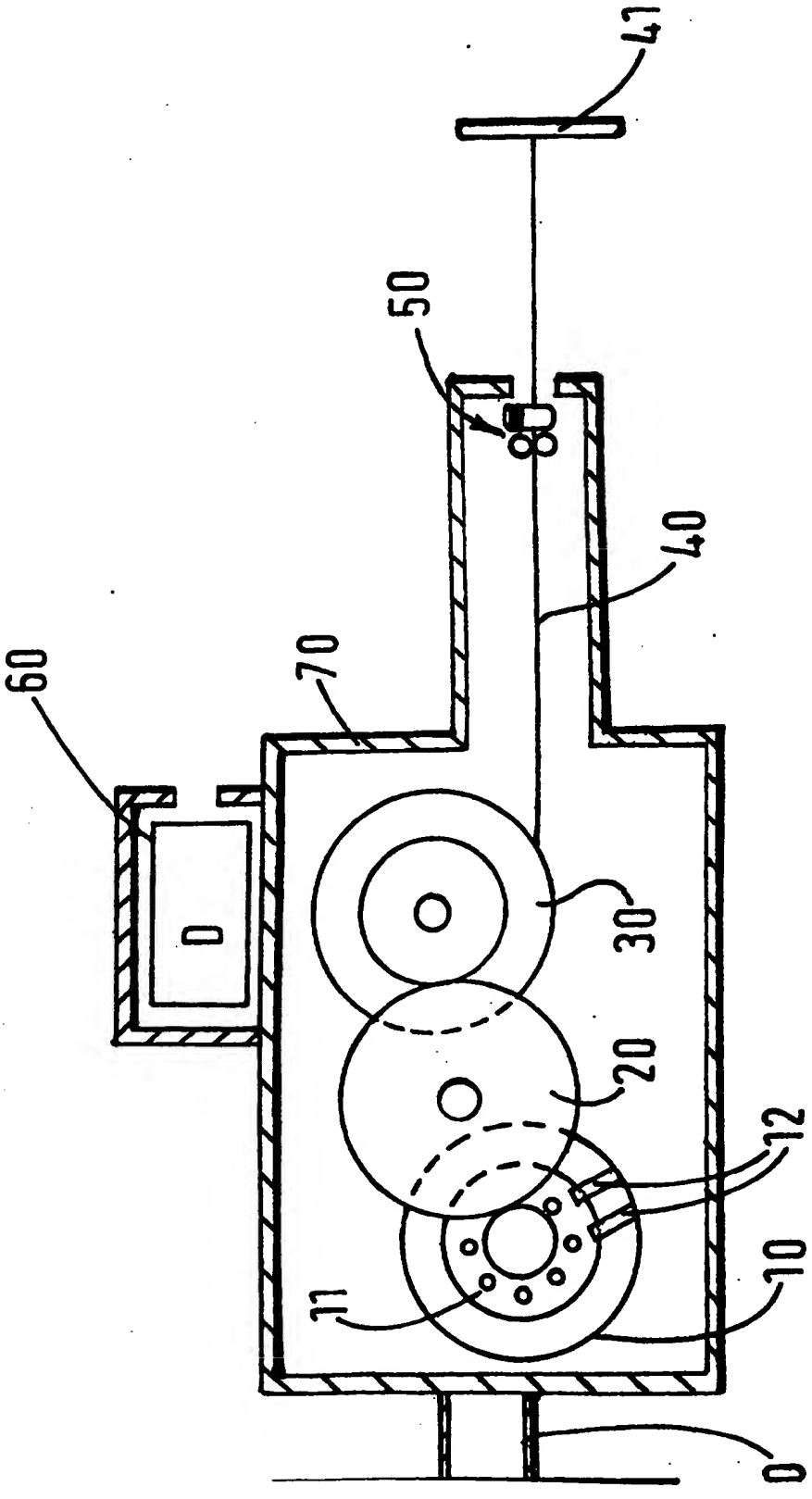
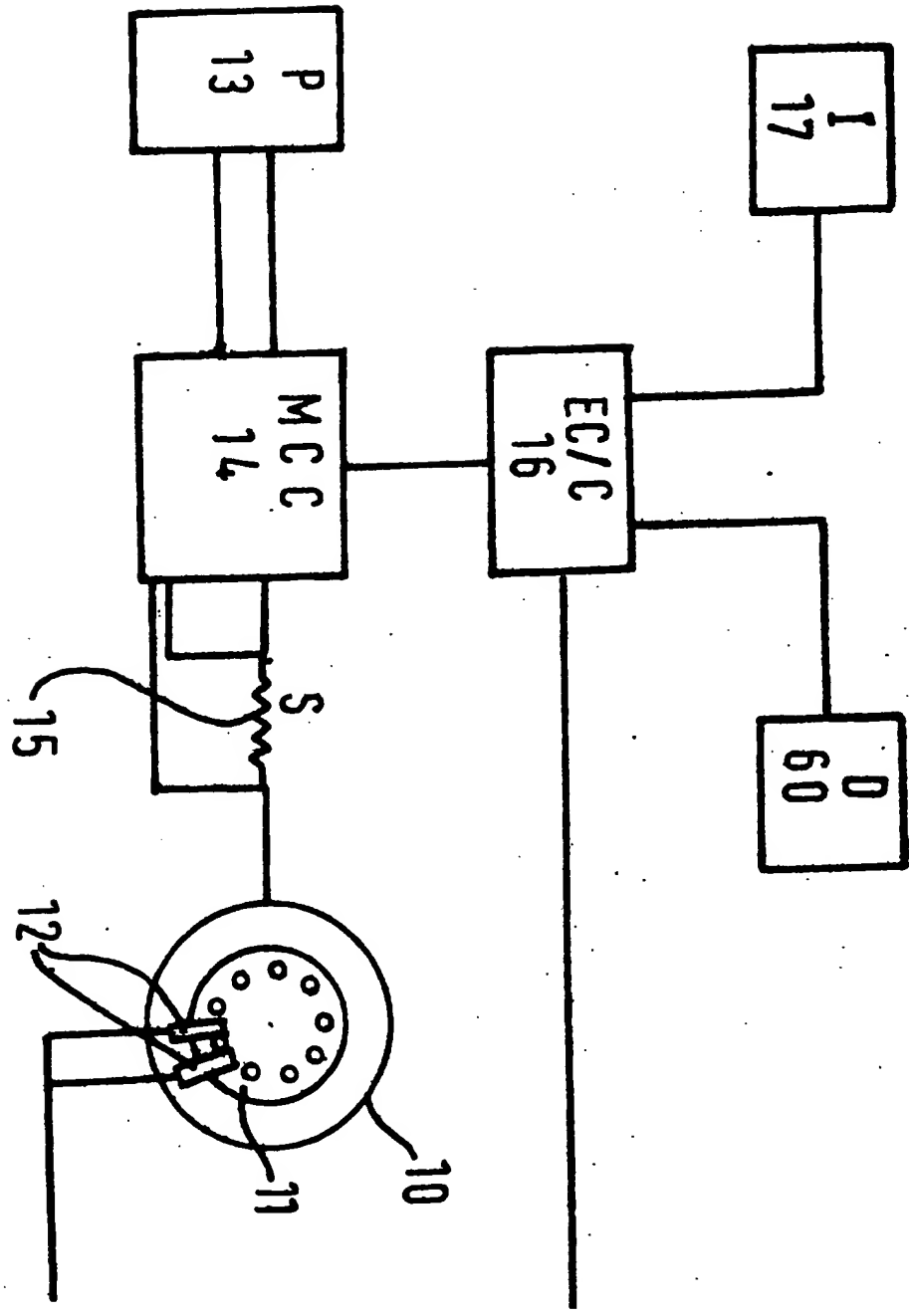


FIG.1

FIG.2



SPECIFICATION

Physical exercise device

This invention relates to a physical exercise device and in particular to a physical exercise device which can be adapted for use in more than one type of exercise.

Generally, physical exercise devices comprise means to generate forces which must be overcome by the user and examples of such devices which are known include the following:

(a) *Weight Stacks* consisting of a variable set of weights to be successively lifted and released by the user by means of a block and tackle;

(b) *Chest expanders* consisting of a resilient member such as a helical spring or telescoped tube system, the user pushing or pulling against the force generated by the resilient member by means of a pair of grips or handles;

(c) *Rowing machines* consisting of a system of springs, dashpots and friction-generating means to simulate the forces encountered by a rower.

A knowledge of human anatomy and of the types of exercise required to develop various athletics skills enables an instructor to "prescribe" appropriate exercise for those in his charge. Frequently, an athlete may require several different types of exercise in any single programme of training and thus there is a need, not met by hitherto-known exercise devices, for a single exercise device which can be adapted for use in more than one type of exercise.

We have now found that it is possible to provide such a device, the essential component of which is a drum, to which a flexible inextensible line (e.g. a cord) is attached at one end and around which the line can be wound. Associated with the drum are means to impart a torque to the drum and therefore a tension in the line, which tension must be opposed by the physical effort of a user pulling on the line.

We have also found that it is possible to control the torque imparted to the drum and thus to control the resistance experienced by the user when pulling on the line. This in turn leads to a physical exercise device which is adapted to generate the forces required to be overcome by exercises of different types.

Accordingly, the present invention provides a physical exercise device, the device comprising a cylindrical drum having one end of a flexible inextensible line of finite length attached to its periphery, the line being wound around the drum and the other end of the line being provided with a grip or handle, means being associated with the drum to impart thereto a torque, means also being provided to control the magnitude and function of the torque imparted to the drum, whereby the said device can generate the forces required to be overcome by different types of exercise. The flexible inextensible line may comprise, for example, a cord, a rope, a wire or a wire rope.

The means to impart a torque to the drum may train, a chain and sprocket system, or a toothed-belt or V-belt transmission system or the like. Alternatively, the drum may be attached directly to the motor spindle, thus avoiding the need for a transmission system.

The means to control the torque imparted to the drum may take the form of a servo system. A controllable source of current may be provided to drive the motor and the actual current flowing may be determined by including in the armature circuit a small-value resistor. The voltage developed across this resistor will be an accurate measure of the current in the armature circuit and hence a good approximation to the torque developed by the motor. If the afore-mentioned source of current is controlled by means of a signal (comprising the amplified difference between the voltage developed across the resistor and a reference voltage), the armature current will be constrained to a value proportional to the reference voltage. The reference voltage may be held at a constant value, when the exercise device will show the properties of a weight stack exercising machine. Alternatively, the reference voltage may be derived as a function of the length of line pulled from the drum or the instantaneous rate of extension of the line, or time; various limiting factors being introduced for convenience and facility of operation of the device. A disc having a series of holes drilled around its periphery in conjunction with two photoelectric beam systems spaced at an odd number of hole pitches may be used in a known manner with a reversible electronic counter to derive extension and rate signals which may be combined, linearly or non-linearly, with other signals (from, for example, limit switches) to form the required function relating to a predetermined force pattern suitable for a particular exercise. It will be apparent that by providing means to combine these various signals in different ways many different force patterns may be obtained giving the exercise device many different characteristics.

It should be understood that the motor may sometimes behave as a generator with a nett flow of power from the armature to the source of current where such power will have to be dissipated.

It is also understood that analogue and digital computing techniques may be employed to carry out the signal manipulations and control functions. Further facilities may be added so that force and displacement signals may be obtained, and calculations carried out on these signals to derive, for example, work done by the user and similar quantities which may be displayed by suitable means such as a digital read-out. A computer or other electronic device may also be used in conjunction with the control circuits so that, through appropriate interfaces, a user can pre-set a required exercise pattern to suit his requirements. A computer system may also be provided having a "learning" mode enabling a particular exercise pattern to be transferred to the computer memory in such a way that it may be reproduced later.

The end of the line furthest from the drum may

grips will be such to facilitate a wide range of exercise, for example, head-harness for flexion/extension of cervical spine, stirrups for leg exercise, waist harness for full body movement, short bars for grip-turning, pressing and rowing bars.

The device may be provided with a universal roller-guide to allow the line to be drawn out at any angle relative to the guide.

The device may be provided with an enclosing cover to protect its various components.

The whole device may be attached in a fixed position to a wall, ceiling or floor surface by means of suitable clamps. Alternatively, the device can be attached to a rigidly-mounted bar or girder so that its position is movable relative thereto.

Electronically-operated means, known *per se*, may be provided, for example, to detect, quantify, register and display the tension in the line and work done by the user in a sequence of exercises. Conveniently, these means may include a digital display and/or a chart-recorder. Thus, the user will obtain an instant "reading" which indicates his effort when pulling on the line. If a chart-recorder is incorporated in the device, a permanent record is provided against which the user or his instructor can monitor his progress.

Thus, with a device according to the present invention, an instructor/therapist can "prescribe" a source of exercises and the device can be operated so as to provide torques to the drum which a user, working according to the various exercises prescribed, must overcome. For such medical/therapeutic applications, the device must be accurately calibrated to maintain a positive and measurable torque to the drum. The resultant resistance afforded to the line (and thus any muscular contraction intended to resist and/or move the drum in the opposite direction to the torque), will also be measurable.

An exercise device according to the present invention can therefore be used as a dynamometer for the assessment of muscular contraction of isometric and isotonic forms, e.g. grip, elbow flexion/extension, hip abductor movement or the like.

The device can, for example, be fixed by means of a frame to a bed and by attaching slings and straps to the line end clip (and thus to a bed patient) a vast range of rehabilitationary exercises can be performed in prone, sitting and supine positions, for all parts of the body, including plantar and dorsiflexion exercises for maintenance of the calf and other muscles acting on the ankle and foot joints.

The present invention will be illustrated, merely by way of example, in the following description and with reference to the accompanying drawing.

In the drawings:

Figure 1 is a schematic view of an exercise device according to the present invention;

Figure 2 is a schematic diagram of a circuit for use with the device shown in Figure 1.

Referring to Figure 1, the device comprises a D.C. electric motor 10 which acts upon a suitable gear train (shown schematically at 20) to drive a drum 30. A line 40 of finite length is fixed at one end to the handle 41. The line extends from the drum 30 to the handle 41 through a universal roller-guide (shown schematically at 50).

A counter and control means incorporating a digital display (shown schematically at 60) is suitably mounted on the device, which is provided with a cover or casing 70. The whole device is attached to a wall, floor, or other rigid surface by clamping means 80.

A perforated disc 11 and sensors 12 are associated with the motor 10. The disc and the sensors form part of the circuit illustrated in Figure 2, which will be described hereinbelow and which is used to vary the load imparted to the drum 30 and thus to vary the resistance encountered by a user when pulling on the handle 41.

Referring to Figure 2, the motor, perforated disc and sensors form part of a circuit comprising a power source 13, a motor current controller 14, a current sensor 15, an electronic controller/computer 16 and an input 17. Display means 60 (see Figure 1) also forms part of the circuit.

The device may be operated as follows:

(i) The power source 13 is actuated. This causes the drum 30 to rewind the line 40 to its "fully-wound" to "zero" position.

(ii) The force to be exerted by the drum 30 against the effort of the user is set at a predetermined level by means of the input 17, acting *via* motor current controller 14 and current sensor 15 upon the motor 10.

(iii) The user pulls out the line 40 to any desired length, the remaining "wound" portion of the line rerpresenting the effective length of the pulling stroke.

(iv) The user exercises by pulling the line between the "set" point and the "fully-unwound" position, the force exerted in each stroke being calculated by the electronic controller/computer 16 and recorded on the digital display 60.

Whilst the present invention has been particularly described hereinabove with reference to "a handle" and to "pulling" exercises, it will be understood that the handle can be replaced, for example, by a stirrup (for engaging the feet of the user for the purpose of leg-exercises) or by a device enabling "press-up", weight-lifting" or "rowing" exercises to be undertaken.

Thus, physical exercise devices according to the present invention are uniquely adapted to measure and display the work actually performed by a user of the device. A variety of arm, leg and body exercises is possible.

CLAIMS

1. A physical exercise device comprising a rotatable cylindrical drum, a flexible inextensible line of finite length, one end of which is fixed to the periphery of the drum and the other end is provided with means to connect a grip or handle thereto and the remainder of the line being wound around the periphery of the drum, the device also being provided with means to impart a torque to the drum and means to vary the magnitude and function of the

direction to said force or forces.

2. A device according to Claim 1, in which the torque is imparted to the drum by means of one or more rotary electrical machines.

3. A device according to Claim 1 or 2, in which the means to vary the magnitude and function of the torque includes a servo system.

4. A device according to Claim 1, 2 or 3, including means adapted to produce an audible or visual signal corresponding to the efforts of a user pulling on the line.

5. A device according to Claim 4, in which the signal is produced by analogue-computer or digital-computer techniques.

6. A device according to any one of Claims 1 to 5, in which the grip or handle attached to the end of the line remote from the drum comprises a head-harness, a waist-harness or a set of rowing-bars.

7. A device according to any one of the preceding claims, including a universal roller-guide to permit withdrawal of the line at any desired angle to said guide.

8. A device according to any one of the preceding claims, which includes an enclosing cover.

9. A device according to any one of the preceding claims, which is provided with means adapted to attach said device to a wall-surface, a floor-surface or a ceiling-surface.

10. A device according to any one of Claims 1 to 8, which is provided with means adapted to attach said device to a rigidly-mounted bar or girder, whereby the position of said device can be varied relative to said bar or girder.

11. A device according to any one of Claims 1 to 8, which is provided with means adapted to attach said device to a bed.

12. A physical exercise device, substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1982.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.